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A CHEMIST'S RETROSPECTS AND PERSPECTIVES[1]

By Dr. RICHARD WILLSTÄTTER

MUNICH

Mr. Chairman, Members of the Chicago Section of the American Chemical Society, Ladies and Gentlemen: Allow me to express my heartiest gratitude for the great honor you have conferred upon me by the award of the Willard Gibbs Medal. At the same time, let me express my deep appreciation to the entire American Chemical Society for having elected me their honorary member at the occasion of my last visit to your country six years ago. With a feeling of deep emotion, I accept the medal which carries the image of that upright and profound character, your great J. Willard Gibbs.

It is the third time that this high distinction has been conferred by your jury on a foreign chemist. I am facing, thus, a great and distinguished assembly to most of whom I am rather a stranger. Not to all of you, however, as there are a certain number of American chemists, who have gone forth from my laboratory and some of whom occupy leading positions in American universities—for instance, at Urbana and in your industry, for example, with the du Pont Company. However, I do not feel like a total stranger; for it is a privilege of the scientist to find friends in every country of the globe, wherever he sets his foot. This is my feeling in your midst.

At any rate, as I do not want to remain a stranger to you, I think I may best introduce myself by presenting some of my scientific memories and ideas. I have been studying chemistry for the last forty-three years; thus, I can look back on two generations of organic chemistry, the development of which is reflected on a small scale in my life.

In my younger days, chemistry was dominated by

[1] Address on the occasion of the presentation of the Willard Gibbs Medal of the Chicago Section of the American Chemical Society for distinguished achievement in science, Chicago, September 13.

two formulas: the formula of methane, representing the idea of the tetravalence of the carbon atom, and the formula of benzene, which expresses the stability, the symmetry and the isomerisms of the aromatic nucleus. These two formulas were the stars which—during my youth—safely guided explorers of the organic system in their navigations. Nowadays, chemical research travels far beyond the limits of this system, chiefly in the realm of substances, which occur in minimal traces, act in high dilutions and are endowed with high and specific reactivity. I refer to the hormones, the vitamins and enzymes, and the immuno-active substances. My mentor, Adolf Baeyer, was asked in his doctor's examination seventy-five years ago, "What is the most important hydrocarbon?" All of you know that the examiner, Professor Mitscherlich, meant benzene. If a student at Harvard were asked to-day, "What is the most important nucleus?," Professor Conant would expect no answer but "Pyrrol."

I was born during the short interval between the enunciation of the periodic system of the elements and the discovery of the asymmetry of the carbon atom, the foundation of stereochemistry. This was the time when Liebig's life was drawing to a close and when his successor Baeyer discovered the phthalein dyes, elucidated the structure of indigo, and when his pupils synthesized alizarine. I learned the three R's when Willard Gibbs enunciated the phase rule upon which his everlasting fame is founded.

As a student, I entered the laboratory of Professor Baeyer, whose successor I was to become twenty-five years later. It was my greatest experience to gain Baeyer's friendship while still a student. The influence of this master, who had and still has a number of distinguished pupils in this country, was unique, due to his strict and pure positivism and his unprejudiced experimental profundity. He loved passionately the experimental method as a child of eight and as a patriarch of eighty. When his parents took him on a trip as a boy of eight, he wrote to his governess at home to take good care of eight date pits, which he had planted in as many flower pots.

He wrote her to pour water over one of them, milk on another, wine on a third, ink on a fourth, and so forth, in order that he might observe upon his return the differences in his palm trees. To a scientist and teacher of his type we owe confidence in the experimental method and liberty in the adaptation of hypothesis to experiment and experiment to hypothesis. His example taught us not to try to direct nature, but to heed her. A young student is fortunate if he can follow a commanding personality as an example in devotion to great tasks without petty regards and intentions. However, the greater the teacher, the more difficult for the pupil to overcome his influence and to develop his own personality in the choice of problems and methods. One should not remain a pupil too long.

Shortly after I received my doctor's degree, I became "privat-docent." In those years, revolutionary discoveries, such as x-rays, the inert gases and the radioactive substances, inaugurated a new era of physics and chemistry. The classical period of organic chemistry enjoyed two last triumphs—the tetravalent oxygen of Collie and the trivalent carbon of Gomberg. My own research problems in those days were of their time, for instance, problems of constitution and synthesis of atropine and cocaine, which contain a peculiar nucleus of seven carbon atoms. The occupation with alkaloids, those natural pharmaceuticals, led me to the life-long hobby of finding means for the alleviation of pain. Thus, I participated in the discovery of a few hypnotics and narcotics, the last number of this series being avertin. Service for the welfare of humanity is not the immediate task of chemistry, but the noblest goal for the chemist. Every one of us invents a narcotic and conceives a benzene theory.

Aromatic compounds are of greater usefulness for the training of pupils. Investigations into the relationship between color and constitution led to studies on the hitherto unknown ortho-benzoquinone and quinonimines, parent substances of various classes of dyes. Prototypes for aniline dyes were found in the so-called meri-quinoid compounds. Most captivating were problems, which entailed hardly surmountable experimental difficulties, the study of the most unstable, most reactive organic molecules. The detached joy in the "performance" is not confined to physical sports. In scientific endeavor, likewise, the experience, that is, the experiment itself, is sometimes more important for the experimenter than the effect as measured in terms of practical consequences. To delve into nature's secrets is something beautiful beyond description; it is an enviable privilege of the scientist to conquer obstacles, when all known devices were deemed inadequate for their circumvention, and to penetrate far enough to lift nature's veil a little more and more from her hidden treasures. This sensation of felicity in the struggle for knowledge is not dimmed by age. To-day, in a study of ferments in blood cells, I live through similar suspense and equal fascination as a beginner forty years ago. According to an aphorism of Lessing, it is not the possession of truth, but the successful struggle for it which constitutes the happiness of the scientist.

Simple plant alkaloids, simple synthetic dyes prepared me for a greater undertaking—the study of the natural pigments. Here, in a certain respect, I digressed from the tradition of my time. Professor Baeyer and Professor Emil Fischer used commercial

preparations as starting materials in their studies of natural products. I preferred to provide plants and animal-organs and to work them up myself. I remember well the time of my first experiments on chlorophyll. I told my assistant to prepare a solution from grass under specified conditions. When he asked, "Shall I order the grass from Merck's?," I took him to the window and showed him the view on our old botanic garden. At our feet lay a meadow, which perhaps was much greener than meadows appear to me nowadays. But I seemed to disregard my own teachings; when I started the study of anthocyanins seven years later in Zurich, I actually bought flowers from Merck, dried powdered corn-flowers. A rose from my own garden had served for preliminary experiments, but it was already November. The powdered material contained but one half per cent. cyanin, but the difficulties of isolation, crystallization and analysis could be overcome. Later on, the experimental field near my house in Berlin-Dahlem bore purple cornflowers, dahlias, asters and chrysanthemums which contained 14 to 30 per cent. pigment and which would have facilitated those first steps.

There is a special thrill and enticement in those first steps which create from an entirely unknown and obscure natural product a well-defined preparation revealing the essential features of its chemical character, but the initial study has to forego the revelation of ultimate details and much is left for pupils and successors. The productive period of man's life is so short and it is nice to gather the roses as well as the grass, besides many other things. Much which we sow will be reaped by others.

Chlorophyll was the main subject of my work during the seven years that I was professor in Zurich. The most surprising result of these studies was the presence of magnesium in complex form in chlorophyll. The oxidative processes, prevailing in the animal organism, are catalyzed by iron derivatives of the haemin group. Plant life, on the other hand, is based essentially on a reduction process. The reduction of atmospheric carbon dioxide to carbohydrate is catalyzed by magnesium. Furthermore, the alcohol phytol, with a skeleton consisting of twenty carbon atoms, was found. It constitutes one third of the chlorophyll molecule and it is the most wide-spread alcohol in nature. The pigment proper was recognized as a system of four pyrrol rings. When you contemplate the green in nature, light and dark leaves, bushes and trees, terrestrial and aquatic plants, the question comes to your mind, Is there one chlorophyll only or are there several or even innumerable? It is always the same chlorophyll, composed of two closely related components, differing slightly in oxygen content.

Is nature as simple in its synthesis of the ornamental colors in flowers and fruits, colors which vary from bright scarlet to dark purple? These dyes are salts of bases with tetravalent oxygen benzo-pyryllium derivatives. There are three main types—pelargonidin, cyanidin and delphinidin—differing from each other by one atom of oxygen. Here, too, nature follows a simple pattern. These alluring problems had been attacked in my laboratory when the great war broke out. Soon, the laboratory was half depopulated, but fortunately my American assistants, Mr. E. K. Bolton and Mr. C. L. Burdick, continued their work on pelargonium, aster, sage and chrysanthemum pigments and attained great success.

These studies of well-defined chemical substances served as a training in biochemical research. Increasing specialization usually forces the chemist very early to choose a special field in physical or inorganic, organic or biological chemistry, but biochemical problems are frequently of a highly involved nature. Is it not advantageous, therefore, to devote years—not necessarily decades—of preparation to the study of chemical methods and of pure substances? Ferments or enzymes as well as problems of platinum catalysis and inorganic investigation on alumina and silici were my problems in recent years.

All chemical processes in the organic world, in each animal or vegetable cell, are ruled and guided by organic catalysts—enzymes. Their nature was veiled until recently in impenetrable darkness. We had no conception as to whether enzymes were at all definite substances. Are the vital chemical reactions catalyzed by definite organic compounds of puzzling structure, as, for example, by chlorophyll, a true enzyme; or are they catalyzed by a haphazard array of well-known substances in a specific physical arrangement and degree of dispersion? I shall have the honor to-morrow to say a few words on the development of our conceptions in this respect. Enzymes are the most delicate and the most efficacious reagents in chemistry. They occur naturally in mixtures which can be compared to systematic collections of various precision instruments. If one destroys the living tissue or cell, then these mixtures can still be found, but no longer in an orderly and protected condition. We open a lock with a single key, not with a whole key-ring, and we turn a screw with a screw-driver, not with a tool-kit. This emphasizes the necessity of separating natural mixtures of these precision instruments into their individual members. Our chemical technique and manufacturing processes are usually drastic and crude, resembling forces of the inorganic rather than of the organic world. It is our task to approximate more and more the delicate methods of the living cell, where reactions proceed at normal temperatures and pressures, with mild reagents and with the most subtle catalysts. When we dare to tackle greater problems

in spite of the shortness of human life, the work carries us further and it grows beyond us. In that case we do not create, but unveil.

From this bird's-eye view of my memories and ideas, I return to this assembly and to the great country whose hospitality I am enjoying. A few days in this center of magnificent activity, a few hours in the overwhelming exposition of the Century of Progress have deeply impressed me with the ingenious expressions of the technical spirit of America. In twentieth-century Chicago, in the Century of Progress, we recognize better than anywhere else the significant dualism of scientific endeavor. Has mankind really progressed through the centuries in art, philosophy, morals, ethics, tolerance, humanity, in one word, in religion? It seems to me that each generation and each individual must start anew and develop in certain aspects its own ideas, its own standards and its own faith. Thus the contrast between human and technical development is steadily increasing. I agree with Sarton, the historian of the exact sciences, when he writes: "The acquisition and systematization of positive knowledge is the only human activity which is truly cumulative and progressive." Constant and permanent progress is only achieved in science and its applications, industry and medicine. Isaac Newton's saying: "If I saw further, it was because I stood on giant shoulders," holds for every one of us. We all have thousands of great teachers and we, ourselves, contribute to the growth of the structure of fundamental and applied science to greater height. Oftentimes we may ask ourselves with severe scruples: Is mankind really becoming wiser, better and nobler? Has the power of religion grown, to render impossible hate and strife between races and nations? Let us wish that religion attains the goal of blessing mankind with love and peace. The ever-increasing beauty and power of science are manifest. While I hinted at the contrast between the spiritual and the scientific, I strongly sense that which is common to both religion and science. Both are truly international, both serve in the end the common weal of men.

WELCOME TO THE INTERNATIONAL GEOLOGICAL CONGRESS[1]

By Dr. HENRY FAIRFIELD OSBORN
AMERICAN MUSEUM OF NATURAL HISTORY

ON behalf of President Davison, the trustees and the scientific staff of the American Museum of Natural History I have the honor to extend a cordial and open-hearted welcome to the delegates and members of the International Geological Congress in its sixteenth session.

We feel honored by the presence of representatives from China, Japan, South Africa, Argentina, Cuba, Canada, Norway, Denmark, the Netherlands, Poland, Belgium, Germany, Austria, Hungary, Czechoslovakia, Rumania, Italy, France, Scotland and England.

As guests of the American Museum you are invited to enjoy our exhibition halls; to study our preparation laboratories; to examine our reserve collections; to note our peculiar methods of research; to observe our independent printing and publication; to visit the library and study its methods of distribution and exchange with over 900 of the leading scientific institutions of the world; to note the special building devoted to public and scientific education, which touches the school, college, university and research life of the entire country. Then, after your journey to Washington and through America, you are especially invited to return to our museum and take advantage of our warm hospitality to investigators from all parts of the world, selecting your own material for research. You will see much that is entirely novel and, at first thought, even foreign to a natural history museum—for instance, that anthropology is under the same roof as zoology and geology, also that astronomy is embraced in our scheme of the sciences; still more surprising, that there is a very live department of experimental biology and that in the building section to be devoted entirely to bird life there will be special provision for experimental ornithology.

You may wonder how these many branches are financed and how during the past twenty-five years it has been possible to expend no less than $38,000,000 on the development of all these branches. People who do not know imagine that we Americans have the golden tree of the Chinese and that all that is necessary is to shake the tree for a shower of millions of money; this is very far from the truth—in fact, we have to work extremely hard for every appropriation and for every gift. I will tell you our secret:

So far as public funds from the state and municipality are concerned, we must demonstrate practically that we are a living and active force in the education of the vast scientifically ignorant population that surrounds us. Accordingly, first, we touch 32,000,-

[1] Address at the luncheon at the American Museum of Natural History, July 21, 1933.

000 school lives each year and through this contact gain the confidence and eventually the warm friendship of the rulers of the city and state; second, knowing that the intelligent class includes not only money-getters but men and women of imagination and vision, we have sent out expeditions—on sea and land, on the rivers, plains, mountains and deserts of every continent, to the Arctic and the Antarctic—under young and dauntless explorers who have the art not only of discovery but of writing interestingly about their discoveries, thus making it possible for us to popularize the expeditions in our many books, magazine articles and newspapers and arouse a once listless and indifferent public to the deep fascination of science.

These are our secrets, now used by many of our sister institutions in America, and we hand them all over to you, without reserve.

However, do not imagine for one moment that we lose our perspective; we spend far more money on scientific research and publication than we do on the popularization of knowledge, and we take far more pride and satisfaction in scientific cooperation and interchange of new and sound ideas than we do in any of the more obvious and visible exhibits and displays in which art and science are combined.

In closing, let me say that the American Museum is indebted beyond measure to the cordial and friendly cooperation not only of the scientists but of the governments that are represented in this congress. Among our friends and allies are enrolled all the South American countries, all the governments of the great continent of Africa, most of the countries and institutions of Asia, all the institutions of Europe, of Great Britain, Canada and Australia. From the old institutions of Europe we received our baptism and inspiration, and we can never repay our indebtedness to them.

Of all the American institutions, that which has stood foremost in cordial relation with the American Museum is the United States Geological Survey, with which we have been cooperating for the past thirty-five years and which published without stint our great monograph on the titanotheres. Of the many positions I have the honor to hold in this country there is none I cherish more highly than the title conferred upon me in the year 1924, namely, Senior Geologist of the United States Geological Survey.

SCIENTIFIC EVENTS

IMPERIAL BRITISH STANDARD MEASURES

Nature states that the statutory decennial comparisons of the Imperial standards of length and mass with their parliamentary copies became due in 1932. On the last occasion, in 1922, they were carried out at the British Standards Department of the Board of Trade under the supervision of Mr. J. E. Sears, Jr., the superintendent of the Metrology Department of the Laboratory, who was at that time acting also as deputy warden of the standards. By a subsequent agreement between the Board of Trade and the Department of Scientific and Industrial Research, it was arranged that the National Physical Laboratory should in future undertake the whole of these comparisons on behalf of the board. The present series of comparisons is accordingly being carried out at the laboratory. The primary object of the comparisons is the verification of the parliamentary copies of the Imperial Standard Pound and Yard, any one of which could be used to replace the corresponding imperial standard should it suffer loss or destruction. There are for each standard five parliamentary copies; one is immured in Westminster Palace, and one each of the others is in the custody of the Royal Society, the Mint, Greenwich Observatory and the Standards Department.

In addition to this work, a redetermination of the relationship between the pound and the kilogram will shortly be made, following the scheme which was adopted for the first time in 1922 to 1923. The International Bureau of Weights and Measures, Sèvres, has been invited to undertake a share of the comparisons in this part of the program. Finally, the principal reference standard pounds at the National Physical Laboratory, together with an auxiliary standard pound belonging to the Board of Trade, will be verified by comparison with one or more of the parliamentary copies of the pound; a corresponding verification of kilogram standards from the laboratory and the Board of Trade will also be made. The weighings are being made on a new balance which has recently been constructed at the laboratory for precision weighings of the highest accuracy. This balance is contained in an inner vault, and all its controls are operated from outside, so that the observer does not enter the vault during any one series of weighings. The indications of the balance are recorded optically on a scale placed some seven meters away.

FEDERAL FUNDS FOR MEDICAL CARE

RULES governing the expenditure of federal funds for medical, nursing and dental care of sick and destitute unemployed persons who are "on relief" have been announced by Harry L. Hopkins, federal emergency relief administrator.

The regulations seek to improve conditions of

service for the unemployed, the professions and the relief officials in the localities under the immediate supervision of which the needy sick are cared for.

The use of federal relief money for medical care is limited to service in the home or office call. Federal funds can not be used to pay hospital bills or for treatment in nursing homes or clinics. Office service for ambulatory patients is permitted, on the understanding that it shall not supplant the services of clinics already provided in the community.

Standard agreements between relief officials and physicians provide for attendance of not more than two weeks or ten visits in cases of acute illness and not more than one visit a week for a period not exceeding two or three months. Cases requiring more protracted calls of greater frequency will be subject to reinvestigation by the local emergency relief administration.

In obstetrical cases, provision is made for prenatal and postnatal care, and exercise of "due caution" that undue risk be not involved to patients for whom hospital care may be imperative. Other and special cases and medical and nursing care, not included in the standard procedure, may be made the subject of special agreements in harmony with the general policy laid down by the administration.

The "essence of such a policy" is said to be, on the part of the relief administration, recognition of the traditional family and family-physician, physician-nurse and dentist-patient relationship in the authorization of medical nursing and emergency dental care of indigent persons in their homes, and agreement by the physician, nurse and dentist to "furnish the same type of service as would be rendered to a private patient, at a minimum consistent with good professional judgment, and an agreed rate which makes due allowance for conservation of relief funds."

"The common aim," it is stated, "should be the provision of good medical service at a low cost—to the mutual benefit of indigent patient, physician, nurse, dentist and taxpayer."

State and local medical, nursing, dental and pharmaceutical organizations will be asked to designate advisory committees to work with the relief executives in the states and communities in formulating more adequate and uniform policies.

THE NEW YORK BOTANICAL GARDEN

THE Botanical Garden will lose twenty-five of its "most efficient workers" at the end of this month, when the activities of the Emergency Unemployment Relief Committee's Women's Work Bureau cease, according to a statement made by Dr. Elmer D. Merrill, director of the garden. Since November, 1931, groups of 6 to 132 women have been working daily in the laboratory, library, herbarium, offices and conservatory at salaries of $12 and $15 a week paid by the relief committee.

Almost two years ago Dr. Merrill requested Miss Ollie A. Randall, head of the work bureau, to supply the garden with "a half dozen women workers with no special qualifications," as an experiment. The six were set to work mounting botanical specimens and clerking in the reference library.

As a result the staff of women was increased gradually to ninety, ranging in age from twenty to fifty years and in occupations from telephone operators to reporters. When the committee's funds were low in the summer of 1932, the number of workers dropped to twenty, but last winter it was increased to 132 at one time. Lack of funds resulted in the present small staff.

The work done varied considerably. At one time there were six artists working on black and white colored sketches of specimens. Plates were made from these sketches later, and some were used to illustrate botanical articles.

The most important work accomplished, according to Dr. Merrill, "was putting the library into the herbarium." Four hundred thousand typed original descriptions and photographs of types of flora were pasted on folders containing dried specimens of the flora.

A card catalogue containing the names of all species of flora found in the Polynesian Islands was completed, giving the titles and authors of articles about each species, with the publications in which they appeared. More than 50,000 cards are in this catalogue and duplicates are in the Bishop Museum at Honolulu.

An index of all botanical literature pertaining to flora found in eastern Asia has also been completed. A page-by-page survey of 700 sets of periodicals, some of them containing more than 150 volumes each, was necessary to complete this index, as well as translations of many titles from Russian, Latvian, Japanese, Chinese and Polish periodicals. There are now about 17,000 cards, containing the titles, names of authors and publications and, in the case of foreign-language articles, summaries of all articles published on Oriental flora.

Two million specimens in the herbarium, formerly classified only by species in geographical units, were reorganized; 300,000 other species were labeled and filed. In addition, public exhibitions in the administration building, which "have been gathering dust and mold for twenty-five years," have been cleaned and polished.

DISSOLUTION OF THE AMERICAN SECTION OF THE AEROARCTIC

AMONG different scientific institutions which suffered in connection with the program of economy in government expenditures is the American section of the Aeroarctic. When this international society for the exploration of the Arctic regions by aircraft was organized in Germany, it was decided that every country which took part should contribute for the work a certain amount, which would be based on its population. For the countries with a population of over fifty million people this amount was fixed at $300 per year.

The American section of the Aeroarctic was founded in 1928.[1] The following year the Congress passed a bill making an annual appropriation of $300 for a period of five years (1929–1933). The appropriation for 1933, however, has been cancelled by the Congress. Through this act the American section of the Aeroarctic lost not only the necessary funds, but also its international standing. The American ambassador in Berlin was instructed by the Department of State to take the necessary steps to give up the membership.

The section could not continue its work as a national organization. The membership dues of $1 a year are hardly sufficient to pay for routine expenses. To increase the dues under present conditions is not advisable and there is no hope of procuring private funds. The transformation of a section of an international society into a national society would require complete reorganization.

Taking into consideration all these conditions, the executive committee of the section has decided to discontinue its activities. A vote of the members of the section showed that a large majority of members recognized that its dissolution is unavoidable.

During the brief time of its existence the American section contributed a great deal to the common cause of the Aeroarctic. It was instrumental, through cooperation with the citizens of Fairbanks, the United States War Department and the Alaskan Road Commission, in establishing a landing field, costing about $12,000, at Fairbanks, Alaska. This field was prepared in anticipation of the plan of the Aeroarctic for its first flight across the North Pole, which unfortunately was not realized because of economic conditions. The American section took an active part in finding means for the construction of a special double compass for observations on the *Graf Zeppelin* during its flight of July, 1931, for the Aeroarctic. On that flight the American section was represented by Lieutenant-Commander Edward H. Smith, of the United States Coast Guard.

In view of the important results achieved by Aeroarctic's Polar expedition in the *Graf Zeppelin*, it is to be hoped that ultimately plans for polar flights with scientific programs prepared by the Aeroarctic may be realized. They would add much to geophysical knowledge.

I. TOLMACHOFF

CARNEGIE MUSEUM,
PITTSBURGH, PENNSYLVANIA

[1] SCIENCE, April 6, 1928.

THE ONE HUNDRED AND FIFTIETH ANNIVERSARY OF THE HARVARD MEDICAL SCHOOL

CEREMONIES to mark the one hundred and fiftieth anniversary of the Harvard Medical School, in which President James Bryant Conant and Dr. A. Lawrence Lowell will take part, will be held on October 6 and 7, according to an announcement made by Dean David L. Edsall.

According to the records of the Harvard Corporation, the opening of the Medical School dates from October 7, 1783, with the induction into office of John Warren as professor of anatomy and surgery and Benjamin Waterhouse as professor of the theory and practise of physic.

The ceremony will be held at the Harvard Medical School and at three of its affiliated hospitals, the Massachusetts General Hospital, the Boston City Hospital and the Peter Bent Brigham Hospital. Following an inspection of these hospitals in the morning, an afternoon program has been arranged for the alumni, including a series of lectures by members of the faculty on work now being done at the school. The one hundred and fiftieth anniversary dinner will be in the evening.

On October 7, formal ceremonies will be held in Cambridge to celebrate the anniversary. The corporation records contain a long-hand account of the original exercises in 1783, and the program for October 7 has been designed to repeat in part the original exercises.

At 10:30 a procession of university officers and faculty and alumni of the Medical School will form at University Hall in the College Yard, and will proceed to Sanders Theater. Here the program will include a brief speech by President Conant and an address by Dr. Lowell, the original inauguration orations of Professors Warren and Waterhouse, and the psalms which were sung at the occasion one hundred and fifty years ago. Dr. Warren's oration will be read by Dr. J. Lewis Bremer, Hersey professor of anatomy, and Dr. Waterhouse's oration by Dr. Henry A. Christian, the present holder of the Hersey professorship of the theory and practise of physic. These chairs are the two oldest endowed professorships in the school.

In 1788, the university conferred its first medical

degree on two students. Since then the school has grown steadily, and at commencement last June it granted 131 degrees. The faculty has grown from the original three professors to a present teaching staff of over one hundred and thirty members.

RECENT DEATHS

DR. E. N. LOWE, director of the Mississippi State Geological Survey since 1909, and professor of geology at the University of Mississippi since 1924, died on September 12, at the age of sixty-nine years.

THE death is announced on September 4 of Dr. John Playfair, a past president of the Royal College of Physicians of Edinburgh, and consulting physician to the Royal Hospital for Sick Children.

A CORRESPONDENT writes: "Herman Paul Sachse, who had devoted his life to the design and production of scientific instruments, died August 12, 1933, at the age of fifty-three years. Mr. Sachse, who was born in Germany, first entered the scientific instrument industry as an apprentice in the Zeiss Optical Works in Jena. In 1911 he came to America to accept a position as superintendent in the plant of Eugene Dietzgen Company in Chicago. His skill in the testing and inspection of optical instruments later opened an opportunity to enter the employ of the Bausch and Lomb Optical Company in Rochester, as general inspector. In 1918 his services were secured by the Central Scientific Company for the making of optical devices for the control of gun fire in the war. At its close he assumed full charge of the production of scientific instruments and laboratory apparatus in the factory of this company, first as factory superintendent and later as factory manager. Mr. Sachse's unusual ability as an apparatus and instrument designer, his intimate knowledge of manufacturing processes and his well-developed artistic sense enabled him to develop instruments of precision which could be produced economically in the small quantities in which such products are made, but still of the perfect proportions and pleasing appearance that really fine instruments justify."

SCIENTIFIC NOTES AND NEWS

SIR WILLIAM BATE HARDY, fellow of Gonville and Caius College, Cambridge, and director of Food Investigation at the Department of Scientific and Industrial Research, has been nominated as president of the British Association for the Advancement of Science for next year when the meeting is to be held at Aberdeen.

DR. HERMAN SCHLUNDT, professor of physical chemistry and since 1911 chairman of the department of chemistry at the University of Missouri, is suffering from a severe attack of encephalitis lethargica.

PRESIDENT ROBERT G. SPROUL, of the University of California, calls attention to the fact that the award of the Langmuir Prize by the American Chemical Society to Dr. Frank H. Spedding, instructor in chemistry, is the third in succession that has been made to instructors or graduates of the university. The first award was made to Dr. Linus Pauling, lecturer in chemistry, and the second to Dr. Oscar K. Rice, Ph.D. (California, '26), now at Harvard.

PROFESSOR DOUGLAS JOHNSON, of Columbia University, has been decorated by King Alexander I of Yugoslavia with the Order of Saint Sava, Second Class, with Star. The presentation was made in New York City by the consul general of Yugoslavia.

DR. OTTO RENNER, professor of botany at Jena, has been elected a member of the Saxon Academy of Sciences.

HONORARY doctorates have recently been conferred by the Agricultural Institute at Vienna on Dr. Otto Appel, director of the Biological Institute for Agriculture and Forestry, Berlin; on Dr. Hans Molisch, professor of plant anatomy and physiology at Vienna, and on Dr. Christoph Wagner, professor of forestry at Freiburg i. Br.

DR. WALTER A. COOK has been appointed head of the department of chemistry at the University of Akron, to succeed H. E. Simmons, who has been elected president of the institution. Dr. Cook has been connected with the department of chemistry at the University of Akron for the past seven years. Dr. Howard I. Cramer, research chemist with the Goodyear Tire and Rubber Company, has been appointed to take charge of classes in rubber chemistry and inorganic chemistry at the university.

DR. GEORGE STEPHEN JOHNSON, professor of psychiatry at the University of Colorado Medical School and director of the work of the Colorado Psychopathic Hospital, has been appointed professor of neuropsychiatry at the Stanford Medical School. Dr. Johnson will carry on the work of the late Dr. H. G. Mehrtens, who died on February 28.

DR. G. C. CHANDLEE, head of the department of chemistry at the Pennsylvania State College, will act as dean of the Graduate School this year during the absence of Dean F. D. Kern, who will be acting dean of the College of Agriculture and Mechanic Arts of the University of Puerto Rico.

IN the issue of SCIENCE for September 15, it was stated that Dr. Harry M. Zimmerman had been ap-

pointed to an associate professorship at Yale University, with the implication that it was in the department of anatomy. Dr. Zimmerman is a member of the department of pathology.

DR. D. O. MORGAN, senior research assistant at the Institute of Agricultural Parasitology, St. Albans, has been appointed lecturer in helminthology in the University of Edinburgh and in the Royal Veterinary College.

DR. WERNER CATEL, of the University of Berlin, has been appointed professor of children's diseases in the University at Leipzig.

DR. CURT STERN, formerly of the Kaiser Wilhelm Institut für Biologie, has been appointed to a research fellowship in the newly organized department of zoology at the University of Rochester.

A. B. EVANS, of the University of Michigan, has been appointed to the fellowship offered by the Firestone Tire and Rubber Company in rubber chemistry at the University of Akron for the academic year 1933–34.

HOWARD A. SMITH, recently of the University of Illinois, who has been granted a National Research fellowship in chemistry for the year 1933–34, has taken up the study of the rates of decomposition of metastable metallic solid solutions at the Metals Research Laboratory of the Carnegie Institute of Technology, Pittsburgh.

DR. KURT LEWIN, of the University of Berlin, known especially for his work in child psychology, has been named acting professor of psychology at Cornell University for the coming academic year. Dr. Lewin, who was dismissed by the Hitler government, goes to Cornell University as a result of appropriations from the Rockefeller Fund and from the Emergency Committee in Aid of Displaced German Scholars, of which Dr. Livingston Farrand is chairman.

ACCORDING to a press dispatch, Dr. Heinrich Poll, professor of anatomy at the University of Hamburg, has been retired on account of "non-Aryan" descent, and Professor Albrecht Mendelssohn-Bartholdy, professor of international law, has been retired "for reasons of administrational simplification."

The Collecting Net reports that Dr. P. W. Whiting, professor of zoology at the University of Pittsburgh, has been invited by Dr. Chas. B. Davenport to spend the coming year at the Station for Experimental Evolution, Carnegie Institution of Washington, Cold Spring Harbor, New York. Dr. B. R. Speicher will act as research assistant to Dr. Whiting under a grant from the Committee on the Effects of Radiation on Living Organisms of the National Research Council.

DR. JULIUS TANDLER, professor of anatomy at the University of Vienna, has accepted an invitation of the Chinese government to lecture during the next semester at the Universities of Peking and Shanghai.

THE Chicago Medical Society gave a reception and dinner to officers of the American Medical Association and its constituent medical societies in the Hall of Science, Century of Progress Exposition, on September 22. Dr. Dean DeWitt Lewis, of the Johns Hopkins Medical School, president of the association, spoke on "Medical Organization," and Dr. Eben J. Carey, director of the medical section of the Century of Progress, gave an illustrated address on "A Century of Progress."

THE Gehrmann Lectures for this year will be given on October 16, 17 and 18 at the University of California College of Medicine, San Francisco, by Dr. Karl F. Meyer, director of the George Williams Hooper Foundation and professor of bacteriology. The subjects are: "Undulant Fever, Bang's Disease and Malta Fever," "Equine Encephalomyelitis" and "Psittacosis."

LECTURES in the Smith-Reed-Russell series at the School of Medicine of George Washington University have been announced for the first semester of the present academic year. Professor George Barger, University of Edinburgh, speaks in September; Professor W. W. Cort, the Johns Hopkins University, in October; Professor James W. Jobling, Columbia University, in November; Professor Howard T. Karsner, Western Reserve University, in December, and Dr. Arthur Cramp, of the American Medical Association, in January. The various subjects to be presented will be announced later.

THE Smithsonian Institution has been advised by the State Department that the Government of Mexico, in view of the fact that economic conditions in the American countries have not improved in general, has postponed until the year 1935 the meeting of the Seventh Pan American Scientific Congress, which was called to meet at Mexico City in November of this year.

THE twenty-second Annual Safety Congress will be held in Chicago, from October 2 to 6, with headquarters at the Stevens Hotel. Three general sessions will be sponsored by the industrial health section: the first on dermatitis and other skin disorders; the second on a practical medical program for industry, and the third on the eye in relation to industry. Dr. Harold S. Hulbert, Chicago, will conduct early morning classes in practical psychology, on "Mental Training for Safety."

APPLICATIONS for the position of botanical artist must be on file with the U. S. Civil Service Commis-

sion at Washington, D. C., not later than October 26. The entrance salary for this position ranges from $3,200 to $3,700 a year, less a deduction of not to exceed 15 per cent. during the fiscal year ending June 30, 1934, as a measure of economy, and to a deduction of 3½ per cent. toward a retirement annuity. Competitors will not be required to report for examination at any place but will be rated on their education and experience. Applicants must have completed a course in art at an institution of recognized standing, or must have equivalent standing from having studied under private tutors. In addition, applicants must have had at least five years of practical experience, illustrating live-plant material, including water color, oils, pen and ink, and pencil drawings.

Industrial and Engineering Chemistry states that applications for grants from the van't Hoff Fund, established in 1913 for the endowment of investigators in the field of pure and applied chemistry, should be sent before November 1 to "Het Bestuur der Koninklijke Akademie van Wetenschappen, bestemd voor de Commissie van het 'van't Hoff-Fonds,' Trippenhuis, Kloveniersburgwal, Amsterdam C, Holland," with a detailed account of the proposed use of the grant and of the reasons on which the candidates base their claim.

ACCORDING to the London *Times,* each of the Nobel Prize winners this year will receive 170,331kr, (£9,465), about £80 less than last year's winners. The slight decrease has been caused by the fluctuations in the yield of the Nobel Fund investments.

A NEW building to form the future home of the Prince Leopold National Institute of Tropical Medicine is approaching completion in Antwerp.

SIR ROBERT HADFIELD has made a gift of £5,000 to the University of Sheffield in commemoration of the visit of the Iron and Steel Institute to Sheffield in 1905, when he was president, and of the coming visit of the institute to Sheffield this month. He hopes that the money will be used for the advancement of metallurgical knowledge. Sir Robert Hadfield, who is a doctor of metallurgy of Sheffield University, built and equipped one of the metallurgical research laboratories at the applied science department of the university.

The British Medical Journal states that the President of the French Republic has recently signed a decree which endorses the plan, put forward by the University of Paris, for an institute of industrial hygiene and occupational medicine, to be attached to the Faculty of Medicine. This institute will be composed of three sections: (1) a section of industrial hygiene which will be concerned with the prevention of industrial diseases and with public health; (2) a section of occupational medicine which will be concerned with the clinical study and treatment of occupational diseases; (3) a section of industrial chemical toxicology which will be concerned with industrial toxicology.

Nature writes: "The burglary that took place at the Geological Survey and Museum, London, on Friday, August 25, was fortunately not so serious as would appear from some of the accounts in the press. A small case was forced open during the night, and about one half of its contents abstracted. These comprised a color-set of cut tourmalines, a handsome piece of rough beryl, a few cut sapphires showing color variation, a set of cut blue and yellow zircons and a few specimens of diamond-bearing and auriferous concentrates. Several large and valuable specimens were left in disorder in the case and it seems clear that the burglar was disturbed by the night-warder on patrol. The building at Jermyn Street is crowded with scaffolding to support the roof, and very special precautions have to be taken against the risk of fire. The condition of the building has increased the difficulties under which the night watching of the museum is carried out."

THE Berlin correspondent of the London *Times* writes that "General Göring, as premier of Prussia, recently forbade vivisection in Prussia and undertook to put any one practising it hereafter in a concentration camp. Much praise was given in the press to the humane motive underlying this order, but the scientific world was apparently taken aback and there were hurried discussions to establish what was and what was not forbidden. It is now announced that pending the enactment of an Animal Protection Act vivisection is to be defined as the dissection of, or operations on, a living unnarcotized animal in cases where anesthetics are used for similar operations on the human body and in cases where the use of anesthetics is feasible. As serious scientific research in the interest of maintaining health and life can not dispense with scientific experiments with animals, these experiments will not be regarded as vivisection if the following rules are followed: Scientific experiments with animals may be made in scientifically conducted institutions, under the supervision of their heads only if scientific considerations promise definite success. They must be omitted if the question at issue has already been cleared up. They are to be made painless by general or local narcotics."

WITH bird and animal specimens for the study collections of the Academy of Natural Sciences, Philadelphia, Brooke Dolan, who made an expedition to West China for the academy two years ago, has returned from East Greenland where he went as a member of an exploring party representing the academy and the Museum of Comparative Zoology at Harvard

University. The group was under the leadership of John K. Howard, of Boston. The other members were Amory Lawrence; Ernest Fox, geologist; Arthur Cleaves, paleontologist, and Lawrence Kilhan, biologist, all of Boston; Dr. W. G. Smillie, of the Harvard faculty; Henry Mallinckrodt, of St. Louis, and Dudley V. Talcott, of New Haven, owner of the schooner *Norkap,* on which they sailed from Isafyordur, Iceland, late in July. Under favorable weather conditions the voyage was made to Cape Brewster, southern gate-post of Scoresby Sound, whence the *Norkap* cruised north to Kaiser Franz Josef fiord after being unable to enter Davy Sound because of heavy ice packs off shore. For nearly three weeks several members of the party made a survey of musk-ox conditions, getting valuable data as to the size and conditions of the herds which form one of the outstanding life-groups in the Free Natural History Museum, and collecting birds and fossils. In the meantime, Mr. Dolan and Mr. Lawrence camped on the Strindberg Peninsula and centered their work on collecting specimens of foxes, arctic hares, barnacle geese and various birds, and Messrs. Mallinckrodt and Howard took a series of motion pictures of musk-oxen and polar bears. On one occasion the *Norkap* came dangerously near being destroyed by a huge iceberg which drifted to the ship's side in a half gale. Before it had a chance to crush the vessel, however, the anchor was lifted and a safe getaway was made. Late in August the expedition returned to Leith, Scotland, by way of Iceland, and sailed thence for this country.

ACCORDING to the Peking correspondent of the London *Times* the Nanking Government has engaged Dr. Sven Hedin to lead a small Chinese-Swedish survey expedition to Sinkiang (Chinese Turkestan). The object is to find motorable highways which would facilitate trade between the remote interior and the coast. Leaving Kueihua in mid-October, the party will travel westward by motor-car along the ancient silk route to Rome, the longest and, it is claimed, the oldest caravan route in the world. The return journey will be made by the Imperial road through Kansu, with Nanking as the destination. The survey will take eight months, and the highways when completed will be 2,000 miles long.

A GIFT of 3,646 acres of forest land has been made to the University of Idaho by the Forest Development Company of Lewiston for development of an experimental forest. The tract is on Moscow Mountain about twenty miles from the university and will be known as the Moscow Mountain Experimental Forest. While practically all the merchantable timber has been removed, undersized trees have been left intact on most of the area, so that natural regeneration will make replanting largely unnecessary. The forest will serve as a field laboratory for the training of forestry students and experimentation in methods of silvicultural management, as well as a game preserve and for recreational purposes.

DISCUSSION

NOTE ON THE LONG BEACH EARTHQUAKE

IN a recent number of SCIENCE[1] there appears "Notes on the Fall of Columns during the Long Beach Earthquake," by Dr. Thomas Clements. A little earlier a "Preliminary Report on the Long Beach Earthquake" was published by the present writer.[2] (More complete and thorough studies of this shock will appear in a future article, or articles, probably in the *Bulletin of the Seismological Society*). From its content it appears certain that Dr. Clements' article had been sent to publication before the appearance of the paper by the present writer.

Because the circulation of SCIENCE is very much larger than that of the *Bulletin of the Seismological Society,* among both men of science and non-professional readers, it seems desirable and perhaps necessary to comment here on Dr. Clements' article. In so doing it must be emphasized that it is desired to avoid over-positive and dogmatic statements. The phenomena developed by strong and destructive earthquakes are very complex, and thorough understanding of them is far from attained. There is no desire to put aside any valuable suggestion. Nevertheless, Dr. Clements' conclusions are not in harmony with ours and the discrepancies call for attention.

When, in 1857 and later, Mallet used overtoppled and fallen objects in the study of earthquakes he recognized waves of longitudinal vibration only. This view prevailed for a long time, implicitly longer than explicitly. Many such studies have been based upon it. Now, however, we recognize elastic waves of transversal vibration as well, and it is generally considered that these are the more destructive. This, perhaps, is not demonstrated; but it has been proved abundantly, especially in the last 30 years, that the amplitudes of the transversal waves are much larger than those of the longitudinal waves and that the periods of the transversal waves (though still very short) are longer. Besides these there are large-amplitude elastic surface waves—Love waves, so-called, with horizontal-transversal vibration, and Ray-

[1] SCIENCE, 78: 2014, 100–101, August 4, 1933.
[2] *Bulletin of the Seismological Society of America,* 23: 2, April, 1933.

leigh waves, in which the vibratory path is a vertical ellipse in the plane of the ray from the origin. All these waves have different speeds of propagation, and the groups of similar waves endure for greater or less intervals. The arrival and passage of these waves, in part separately and in part together, should produce a confused motion of the surface, with local changes from epoch to epoch. Also, there is no doubt of waves at the surface, especially in basins of loose, wet alluvium, which have been called quasi-elastic and quasi-gravitational. These have still different amplitudes, periods and speeds of propagation. In some instances it is known that objects which fall do so at different stages of the shaking. Therefore, it is an open question whether much can be learned from the study of overtoppled or thrown objects unless it is known that those considered fell at known instants, or during the predominant action of particular groups or kinds of waves.

However, accepting Dr. Clements' observations as carefully and critically made—it is clear that columns are as likely to fall under the action of transversal waves and Love waves as of longitudinal, and very probably more so. The Rayleigh waves may also cause their fall (in this case in the same directions as the longitudinal waves). Thus, if the action does not develop too great complexity, objects may be expected to fall not only toward or away from the source of the shaking, but also, possibly to a greater extent, in directions at right angles to radii from the origin. Such a tendency is discernible in the diagram published by Dr. Clements, although the spread indicated is fairly wide. As pointed out by Mr. Hugo Benioff, of this laboratory, if it is assumed that the directions corresponding to the maximum number of falls are determined by transversal movements, "the mean lines intersect at a point about 5 miles northeast of Long Beach (say 33° 49′ N., 118° 08′ W., approximately). The polygon of errors is smaller for this assumed epicenter and in addition the observations at Wilmington fit in very well, whereas with his (Dr. Clements') epicenter it was necessary to discard the Wilmington observations." It is not intended here to offer this new position as the preferred site for the chief epicenter, but merely to make it clear that the observations are susceptible of more than one interpretation.

As stated in the "Preliminary Report, etc.,"[2] the origin of the first motion is excellently determined within very narrow limits (2 to 5 kilometers, at most 5 miles) at 33° 34.5′ N. Lat., 117° 59′ W. Long., about 3½ miles southwest of Newport Beach and a very little farther from Balboa. A strong motion seismographic record written at Pasadena leaves practically no doubt that this was the source of the first motion of the main shock. Whether the fault-source developed and elongated significantly to the northwest immediately after the initial action is a matter which will be very thoroughly considered later in the more complete report. It may be that this will be found to be the case. At the present time, however, there is no evidence known to the writer to support the hypothesis that a minor shock originating off Newport Beach was followed immediately by a greater discrete shock originating some twenty miles to the northwest. The instrumental records appear to rule this out completely.

There is excellent evidence, supported by the detailed descriptions given in their reports, that many persons felt the arrival of the longitudinal waves followed after some seconds by the arrival of the transversal waves. Whether this will explain the personal impressions of "two distinct series of shocks, one following immediately upon the other," mentioned by Dr. Clements is, of course, uncertain.

It is true, as Dr. Clements states, that the shaking at Newport Beach and Balboa did not appear as violent as at Compton, for example. This will be the subject of discussion in the more complete report. However, there was much evidence of strong vertical shaking at Newport Beach and at Balboa; and there is abundant evidence in many places difficult to reconcile with an epicenter very near Compton. On the basis of much experience it may be stated that the nature and distribution of the effects of the shock are consistent with an epicenter off Newport Beach when the character of the ground throughout the area is taken into consideration.

It is further true, as Dr. Clements states, that there was no "tidal-wave" so-called. There were, however, reports of slight disturbance of the sea surface. The absence of a significant wave is of slight consequence. In the San Francisco earthquake of 1906, there was but little disturbance of the sea surface and no wave, properly speaking, although there is sound evidence that sidelong slipping of the San Andreas fault amounting to several feet (with little, or negligible, vertical offsetting) traversed a submarine course of many miles. For the Long Beach shock there is no evidence of any surface dislocation at all, whether submarine or subaerial. Shocks originating at sea without producing significant seismic sea waves are very common, even when the origins are near coastlines. In detail the cause, or causes, of seismic sea waves are not sufficiently well known, but they have not generally been considered due to vibration of the ground surface which forms the ocean floor.

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THE LOCATION OF EARTHQUAKE EPICENTERS

ACCURATE determination of earthquake epicenters is important, for they are of much assistance in locating active faults. In a recent article on the fall of columns during the Long Beach earthquake, March 10, 1933, Professor Thomas Clements reaches the conclusion that the major shock had its origin in or near Compton instead of on the sea floor a short distance off Newport Beach, as had been indicated by seismograph records. In addition to evidence from overturned monuments in cemeteries, Professor Clements mentions the absence "of a so-called tidal wave, which might have been expected with violent earthquake waves emerging on the sea floor, and this regardless of whether the movement along the fault was vertical or horizontal."[1]

This erroneous conception of the cause of seismic sea waves is common, and has even found its way into a recent text-book of geology. A seismic sea wave is caused by a sudden vertical displacement of the sea floor. The time interval between the arrival of the earthquake vibrations and the arrival of the wave gives an accurate determination of the distance of the displacement from the point of observation, and is, therefore, useful in fixing the position of the origin. Many severe earthquakes have originated under the ocean without being accompanied by sea waves.

In spite of the fact that the San Andreas fault extends under the ocean for several miles, there was no sea wave at the time of the San Francisco earthquake of 1906, because the displacement was horizontal. Earthquakes due to vertical displacements along submarine faults may not always be accompanied by sea waves, for many of the smaller displacements do not extend to the surface. Vertical vibrations, indicative of a vertical displacement, seem to have been dominant near the epicenter of the Santiago-de-Cuba earthquake of February 3, 1932, which originated under the ocean, but there was no sea wave. Absence of a sea wave, therefore, can not be used as evidence that an earthquake did not originate under the ocean.

The evidence from overthrown columns must be used with great caution. If the base of a column is rectangular the direction of fall is usually limited to one of four directions. Some columns topple over, and some fall because they are displaced on their pedestals. If the earthquake is due to a horizontal displacement, columns close to the fault are usually overturned in directions parallel to it. During the San Francisco earthquake of 1906 objects close to the fault were commonly overturned or displaced parallel to it, while at a distance they were mostly displaced at right angles to it.

[1] SCIENCE, n. s., 78: 100–101, 1933.

In densely settled regions the epicenter can usually be located most accurately through a study of the distribution of intensity, but in comparing the relative intensity at different localities it is necessary to consider the character of the foundation material, for the apparent intensity is always much greater on made ground and unconsolidated alluvium, especially when saturated with water, than it is on rock or residual soil. At Long Beach and Compton, where damage as a result of the recent earthquake was great, the foundation conditions are poor.

From seismograph records it is possible to determine the distance to the point where the disturbance started. A displacement must begin in a rather limited area, and then extend rapidly over the fault surface and, sometimes, to adjacent faults. It is therefore possible for the area of maximum intensity to be a short distance away from the point of initial displacement.

When the position of an epicenter is determined from the records made on distant seismographs the error may be 50 km. or more; but in the southern California area, where the Carnegie Institution of Washington has established several stations equipped to study local earthquakes, it should be possible to determine the origin of the initial disturbance with an error of less than 5 km.

If the epicenter of the Long Beach earthquake was near the coast, as is now indicated, it was probably due to a displacement on the Inglewood fault, which was mapped and described as an active fault by me when I investigated the Inglewood earthquake in 1920.[2]

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WHY DO WE PERSIST IN TALKING ABOUT THE "EXPANSION" AND "CONTRACTION" OF CHROMATOPHORES?

ONE may well question the wisdom of adopting a mode of expression which the author himself commonly feels under obligation to repudiate. To those who are familiar with the voluminous literature relating to vertebrate chromatophores, and with the great importance of some of the biological problems which center in them, the following attempt to adjust our terminology to our accepted view-point will perhaps not appear futile. Such persons are well aware of the two chief divergent views which are held respecting the changes of form that these cells appear to undergo in response to stimuli. The first of these is the more obvious interpretation of the phenomena observed,

[2] "The Inglewood Earthquake in Southern California, June 21, 1920," Stephen Taber, *Bull. Seis. Soc. Amer.*, X, 1920, pp. 129–145.

namely, that we have to do with actual ameboid movements of the cells in their entirety. According to this conception, the outlines of the visible pigment masses are nearly or quite coextensive with the outlines of the chromatophores themselves. Not only the contained pigment masses, but the cells which contain them, are believed to actually contract and expand. This view, with various modifications, is still held by a minority of investigators, but little recent evidence appears to support it.

The alternative view asserts that the cell-outlines of the chromatophores are nearly or quite fixed, and that the space thus bounded is at all times occupied by the cell protoplasm or a certain portion of it. This protoplasm does not permit of differential staining, so that it is quite invisible in ordinary histological preparations, and commonly in living material as well. The familiar changes in the apparent form of the chromatophores are due to the movements of the pigment masses in the hyaline protoplasm of the cells. The streaming of these granules is one of the most fascinating as well as one of the most readily observed phenomena available to the microscopist. Successful moving pictures of this process have been obtained by Ballowitz.[1]

This second interpretation of the phenomena of chromatophore reaction is now accepted, with possible qualifications, by probably a large majority of investigators in this field, at least for animals beyond the larval stages. In spite of this fact, it is a curious circumstance that most of these investigators continue to employ the language of the earlier theory, even when they explicitly repudiate it. They speak freely of the "expansion" and "contraction" of the chromatophores, and then promptly proceed to explain, by footnote or otherwise, that they really mean nothing of the sort, but only employ this terminology for the sake of convenience. Any one familiar with recent literature in this field will recognize the truth of my statement.

My suggestion is that we continue to employ the terms "expansion" and "contraction," since something obviously does expand and contract, but that we credit these movements to the things that actually do expand and contract, namely, the pigment-masses within the cells.

For these pigment-masses I propose the following terms:

(1) A *chromatosome* is the aggregate pigment content of any chromatophore, regardless of color.

(2) A *melanosome* is the pigment mass contained in a melanophore.

(3) A *xanthosome* is the pigment mass contained in a xanthophore.

[1] *Pflüger's Archiv,* Bd. 157: S. 165–210, 1914.

Corresponding terms may be employed for the pigmentary contents of erythrophores and guanophores.

The only objection to this terminology which I can think of is the fact that the term "iridosome" has been employed by Ballowitz[2] to designate the clusters of iridocytes (guanophores) which sometimes surround chromatophores of another type. I do not think that the term proposed by Ballowitz well characterizes these loose clusters of cells, particularly since they frequently form an open reticulum, passing from one melanophore to another. His use, in that connection, of the termination "—some" would hardly seem to render it unavailable for the appropriate, as well as more urgent, application suggested in the foregoing note. No one who has observed the pigment mass of a melanophore, particularly in its contracted phase, would hesitate to call it a "body."

It may be that my suggestions, here offered, are not new. Or it may be that there are serious objections to the proposed terminology which I have overlooked. If so, I shall be glad to be further enlightened.

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A RECORD OF YOUNG TARPON AT SANIBEL ISLAND, LEE COUNTY, FLORIDA

AVAILABLE records of the spawning habits of *Tarpon atlanticus* contain no reference to observations made north of Puerto Rico and Cuba other than those reported by L. L. Babcock,[1] and but three notes of the taking of young tarpon along the coast of the United States.

Evermann and Marsh[2] state that *"Tarpon atlanticus* is common about Porto Rico, where it evidently breeds." They record four specimens from 7.5 to 11.5 inches long taken at Hucares. At Fajardo very young fish from 2.5 to 3.5 inches were collected. Beebe and Tee-Van[3] give measurements of 78 to 1,060 mm of five arbitrarily chosen specimens collected in Haiti. Eigenmann[4] records tarpon of 20, 119, 182 and 192 mm at Pinar del Rio, Cuba.

Gill,[5] in 1905, wrote that the tarpon "does not appear to breed at any place along the continental

[2] *Arch. für mikr. Anat.,* Bd. 93: S. 404–413, 1920.

[1] L. L. Babcock. "The Tarpon." 3rd ed., 135 pp., 9 text-figs. Privately printed, 1930.

[2] B. W. Evermann and M. C. Marsh. "The Fishes of Porto Rico." *Bull. U. S. Fish. Comm. for 1900,* 20: p. 80, 1902.

[3] Wm. Beebe and John Tee-Van. "The Fishes of Port-au-Prince, Haiti." *Zoologica,* Sci. Contribs. N. Y. Zool. Soc., 10: 33–36, 1928.

[4] C. H. Eigenmann. "The Fresh-water Fishes of Western Cuba." *Bull. U. S. Fish Comm. for 1902,* 22: p. 222, 1903.

[5] Theodore Gill. "The Tarpon and Lady Fishes and Their Relatives." *Smithson. Misc. Colls.,* 48: 31–46, 5 pls., 7 text-figs. 1905.

coast of the United States," but R. E. Coker[6] reports a six-inch specimen taken in 1921 at Dauphin Island, Alabama, and L. L. Babcock[7] notes that J. E. Cotter has taken three-inch tarpon in a cast-net at Aransas Pass, Texas.

A Leptocephalus stage in the development of *Tarpon atlanticus* has not been seen, but is predicated by the 25-mm specimen, transitional between Leptocephalid and adult form, in the Bureau of Fisheries, Washington, which was taken off Beaufort, North Carolina. Such a stage occurs in allied genera, and is probable in this case also.

Meek,[8] in his "Migrations of Fish," suggests as probable that the spawning of tarpon takes place at sea far enough from the coast to demand a denatant drift of the pelagic eggs and larvae to the coast where early life is passed.

There is adequate foundation for the belief that *Tarpon atlanticus* spawns along the Gulf Coast of Florida. For many years past, during March, April and May, tarpon have schooled in considerable numbers in shoal waters from one half to one mile off the southeast shore of Sanibel Island, Lee County. These schooling fish remain in this locality for some time, and when feeding strike freely at live bait. Milt has been seen escaping from fish in play, and when brought to the release-hook quantities exceeding half a pint have been expressed from a single fish. So far as known, female fish have not been taken from these schools.

Local fishermen are familiar with small tarpon in creeks and brackish pools, and occasionally in inland pools which contain water only during the summer rainy season, and have no communication with salt water.

Young tarpon from 12 to 38 cm may be netted at any time from a large brackish pool on Sanibel Island. Seining this pond in April, 1933, yielded specimens 8.46 and 12.70 cm in length, and weighing respectively 10.5 and 12.5 grams. These young fish are probably of a year's growth, as indicated by examination of the scales.

The coincidence of schools of ripe male fish remaining for some time in this definite area, correlated with the abundance of very young tarpon in the pools and bayous of Sanibel Island, strongly suggests this locality as a breeding-ground. Opinion among local fishermen is unanimously affirmative on this point. Efforts to secure specimens in early stages of development are now being made and results will be recorded later.

MARGARET STOREY
LOUISE M. PERRY

SCIENTIFIC APPARATUS AND LABORATORY METHODS

THE MEASUREMENT OF STEADINESS: A NEW APPARATUS AND RESULTS ON MARKSMANSHIP

THE apparatus shown in Fig. 1 is a modification of several previous forms described by Whipple[1] and Dunlap[2] for the measurement of steadiness in fine eye-hand coordinations. All these involve the essential idea of a series of holes, graded from large to small, and a stylus (electrically connected with a buzzer or counter), which is either thrust into or held stationary in the holes, errors or unsteadiness being counted by the number of contacts with the plate or side of the holes and registered electrically by a counter or buzzer. The present apparatus combines the best features found in the earlier models, with additional improvements, namely: (1) Use of a rotating dial so that the movement is always to the same point; (2) use of a fiber cover with a beveled opening to focalize the target hole in the brass disk; (3) use of a back target covered with white paper for visibility and insulation so as to standardize the distance of inserting the stylus in thrusting; (4) adjustability to the most convenient height for each observer; (5) use of a tapering, pencil-shaped stylus to afford clear vision of the point when approaching the hole, and (6) suggested use with a "Ceneo" impulse counter,[3]

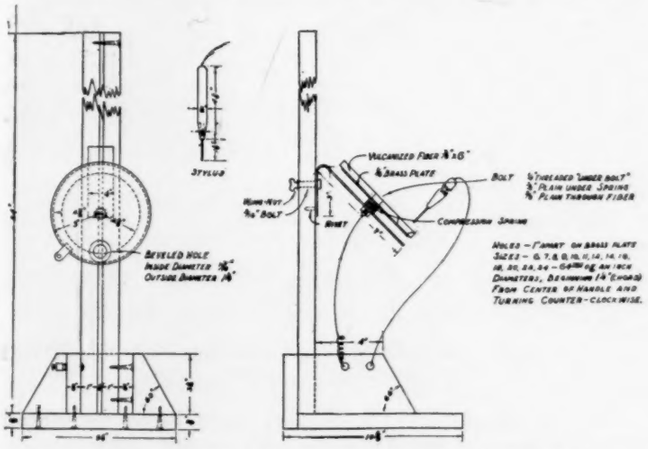

FIG. 1. Apparatus for measurement of steadiness.

[6] R. E. Coker. "A Record of Young Tarpon," *Copeia*, No. 93: 25–26, 1921.

[7] *Op. cit.*

[8] Alexander Meek. "The Migrations of Fish," p. 59. London, 1916.

[1] G. M. Whipple, "Manual of Mental and Physical Tests." Vol. 1, "Simpler Processes." Test 13, pp. 155–160. Baltimore, Warwick and York, 1910. Rev. ed. 1914, pp. 130–147.

[2] K. Dunlap, "Improved Forms of Steadiness Tester and Tapping Plate." *Jour. Exper. Psychol.*, 4: 430–3, 1921.

[3] Central Scientific Company, Chicago, Illinois.

which is fast enough to detect "scratch" hits in the thrusting movement (when it is used with 6 volt D. C.), and counts the total time in contact with the sides when the stylus is held stationary for a period of ten seconds (when it is used with a step down transformer to 10 to 12 volts of 60 cycle A. C., thus measuring 1/120ths of a second).

In work to date, a number of suggestions for a controlled testing situation have arisen: (1) Demonstrate the procedure to the observer and have him try the thrusting 5 times in the large hole, or in the stationary position, hold the stylus in position for two periods of 10 seconds each before starting the test. (2) Assume a stable, seated position, preferably on a stool with feet flat on the floor, left hand braced on table, right arm free from the side, and apparatus approximately in front of the right shoulder in the most comfortable position for moving the forearm through a distance of about six inches. (3) Perform thrusting and withdrawal movements at the rate of one second each in time with a metronome or clock, using ten trials in each hole, proceeding from the largest to the smallest, and repeating the series three more times. Slow up the thrusting movement just before entering the hole, to permit fine corrections of aim. (4) In the stationary position insert the stylus in the hole, close contact for ten seconds and proceed to each smaller hole, and repeat the series three more times. (Doubled for both stylus tests in order to increase accuracy.) (5) Polish the inside of the holes and the tip of the stylus at least once per series, using the fine "crocus cloth" which is obtainable at hardware stores.

This apparatus is of particular interest in relation to an analysis of steadiness in rifle shooting, where Dunlap's earlier form had been used by Spaeth and Dunham[4] to discover a coefficient of correlation of $.61 \pm .106$ between the thrusting type of measurement and score in rifle target shooting of 60 army marksmen, who ranged from poor to expert.

In view of the strong general trend against the various hypotheses of motor "abilities" or "aptitudes" as summarized by Seashore,[5] Adams[6] arranged to repeat and extend the work of Spaeth and Dunham under related conditions.

Other tests were added to form a battery of "steadiness" tests: (1) the Miles ataxiameter measuring postural sway, (2) the Beall and Hall ataxiagraph, for photographing tremor movements of the arm, and (3) a test of rifle steadiness. The ataxiameter[7] and ataxiagraph[8] are adequately described elsewhere. The rifle steadiness test was fashioned after the set-up designed by A. I. Gates[9] in his study on the analysis of marksmanship. A metal stylus is fastened securely to the muzzle of an army 22 rifle, regulation size, and fits into a clasp which is fastened by silk threads to levers which record vertical and horizontal movements on a kymograph drum during target aiming.

For purposes of scoring the records were clipped to the kymograph drum and a writing lever of the same construction as that used in the rifle steadiness test was connected by threads to two opposite dials of the ataxiameter. As the drum is slowly rotated, the experimenter moves this lever so that it accurately traces the kymograph record, translating it into millimeter units which are read directly from the ataxiameter. This technique proved to have approximately 98 per cent. accuracy. The ataxiagraph records were read by placing the transparent photographic film over a grid of penciled lines one mm apart and tabulating the number of deviations of the record as it crossed these lines.

TABLE I

INTERCORRELATIONS BETWEEN FIVE MEASURES OF STEADINESS

	Ataxiameter	Ataxiagraph	St. (thrust)	St. (position)
Ataxiagraph	.48			
Steadiness (thrust)	.44	.46		
Steadiness (position)	.54	.48	.59	
Rifle steadiness	.48	.54	.47	.48

N = ranges from 43 to 56 students in required military drill classes, the N in each case depending on the number of records lost through experimental failures, *e.g.*, photography.

As shown in Table I, the intercorrelations between these tests indicate that they are fairly consistent in measuring the same phenomenon, a result which is corroborated by a similar unpublished study by D. Stephenson at the University of Oregon. At present we can only say that these results on "steadiness" differ markedly from the intercorrelations on most other tests of motor skills, as cited by Seashore (*op. cit.*),

[4] Spaeth and Dunham, "Correlation between Motor Control and Rifle Shooting." *Amer. Jour. of Physiol.*, 56, 249–256, 1921.

[5] R. H. Seashore, "Individual Differences in Motor Skills," *Jour. General Psychol.*, 3: 38–66, 1930.

[6] The writers are indebted to the University of Oregon Military Department for cooperation in this work.

[7] W. R. Miles, "Static Equilibrium as a Useful Test of Motor Control," *Jour. of Industrial Hygiene*, 3: No. 10, 316–331, February, 1922.

[8] C. G. Beall and C. Hall, "A Vibration Recorder and Some of its Applications." *General Electric Review*, May, 1924, 297–303.

[9] A. I. Gates, "The Abilities of an Expert Marksman Tested in Psychological Laboratory." *Jour. Applied Psychol.*, 2: 1–14, 1928.

TABLE II
RELIABILITIES OF TESTS

Ataxiameter $r\frac{1}{2}-\frac{1}{2}$	.81
Ataxiagraph	.69
Steadiness (thrust)	.71
Steadiness (position)	.69
Rifle steadiness	.89

which showed an average correlation of from +.15 to .25.

Considering the rather low reliabilities, which ranged from .69 for the Steadiness (Position) test to .89 for the Rifle Steadiness test (as shown in Table II), these intercorrelations of Table I are quite significant.

Six members of the university rifle team have been tested and found to be very superior to the unselected group on the battery of steadiness tests. With but one exception the rifle team members surpassed the most steady of the unselected group of 50 men students enrolled in military drill classes. On the individual tests the rifle men placed consistently in the eighth, ninth and tenth deciles.

For the present we can only say that the strikingly superior scores of the rifle team may have resulted from the transfer of the intensive rifle training to which these men have been subjected, or following an "aptitude" interpretation, this stability may have been one determining factor in the selection of rifle team members. If such a "steadiness" aptitude exists it should be possible to select from a given sampling of prospects those who can become crack shots and those who will fail, with the reservation, of course, that other factors are probably of equal or greater importance in learning to shoot. Efforts are being made to secure data on the possibility of this type of selection and also upon the possible transfer of training from rifle shooting to the steadiness tests themselves. Further analyses are at present under way to determine the amount of daily and weekly fluctuations and improvements on the steadiness tests themselves and their relation to rate of tremor. Cooperation is invited to test out this type of measurement on practical skills which seem logically to be related.

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A CONVENIENT SLIDE WARMER

THE slide warmer pictured in the accompanying illustration grew out of the necessity, in my research work, of warming a few slides at a time. The warmer can be constructed by any laboratory technician who is handy with tools.

The warming compartment is constructed of roofing tin in the form of a box furnished with a close-fitting cover. The box portion is four inches square and seven inches long. The cover is four inches square and four inches long. In each of two sides of the box are three holes, each three eighths of an inch in diameter. In the bottom of the box is fastened a square piece of insulating material one fourth of an inch thick. An ordinary porcelain electric light socket

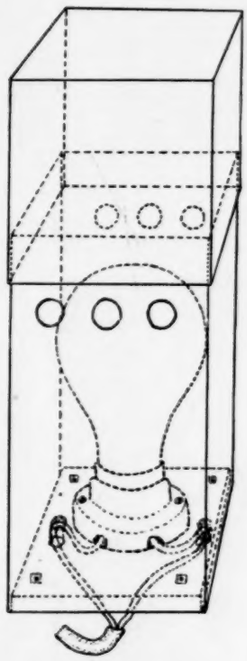

FIG. 1.

is attached to this material, and two holes, one fourth of an inch in diameter, are made in it to permit the passage of the electric wires. Coinciding with these holes, but larger, there are holes made in the tin of the bottom of the box so that the wires will be insulated from the metal of the box. The warmer is placed on its side when in use. A 50 watt bulb produces the necessary amount of heat to cause the paraffin ribbons to spread out within a few minutes after placing the slides on the side of the warmer.

The temperature inside the warmer can be varied in several ways. The cover may be placed on the box far enough so that the circular holes are partially or completely covered. The holes may be left exposed below the cover, as in the illustration, and the warmer placed on a table with one of the three-holed sides in contact with the table. The cover may be removed and allowed to be a fraction of an inch from the box. The temperature may also be varied by using a stronger or weaker bulb. This warmer may be used to keep the balsam sufficiently fluid to make satisfactory mounts.

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SPECIAL ARTICLES

THE EARLIEST KNOWN CEPHALOPODS

FORMERLY the Holochoanites, including the endoceroids and piloceroids, were regarded as the most primitive cephalopods. Later discoveries, however, showed that they are by no means the earliest cephalopods, and that their structure is not simple. While in the Holochoanites the lower part of the siphuncle is occupied by a close succession of funnel-shaped endocones, the corresponding part of the earliest known cephalopods is free from deposits of any kind.

The oldest genus referable to the cephalopods is *Volborthella* from the lower Cambrian of the Baltic areas of Europe. In this genus the conch is straight, the siphuncle is central in location, and Schindewolf[1] has shown that the septal necks are short and relatively straight.

Next in age are several species of *Plectronoceras,*[2] occurring in the Upper Cambrian of northeastern China and Manchuria. In this genus the conch is curved lengthwise, the siphuncle is located close to the concave side of the conch, and Kobayashi[3] has shown that the septal necks are short with their lower margins curved strongly outward, as in the Cyrtochoanites.

In *Plectronoceras,* no connecting rings are present in the intervals between the successive septal necks, and no deposits are found in the interior of the siphuncle. Apparently the absence of these features is to be regarded as primitive, the introduction of connecting rings and of deposits within the interior of the siphuncle taking place at later stages of development.

Cephalopods with lamellae or tabulae crossing the interior of the siphuncle in a transverse direction make their appearance first in the Middle Ozarkian and become relatively abundant in the Upper Ozarkian. Among genera already described are *Levisoceras, Burenoceras, Dakeoceras, Ectenoceras* and *Clarkoceras.* They belong to the group of Diphragmida, proposed by Hyatt for his genus *Diphragmoceras,* and now known to include about ten other genera. In all but one of these genera the conch is curved lengthwise, the siphuncle is located close to the concave side of the conch, and the tabulae occur in series along the lower part of the siphuncle at distinct intervals from each other. The tenth genus, *Robsonoceras,* is founded by Ulrich and Foerste on the species *Ellesmereoceras robsonense* Walcott. It presents a similar series of tabulae, but the conch is straight, and the siphuncle is located close to the side regarded as ventral.

In these Diphragmida the concavity of the tabulae usually is small or at least moderate. In some cases they are sufficiently deep to suggest blunt endocones. In no case, however, are these endocones so closely crowded as to form an apparently continuous series, nor are their central parts ever narrowed downward into a relatively acute point, nor connected by a narrow, vertical, continuous tube, corresponding to the endosiphotube of the Endoceratidae. In this sense the Diphragmida may be regarded as more primitive than the Holochoanites, though making their appearance subsequent to forms in which deposits within the interior of the siphuncle are entirely absent.

In the Upper Ozarkian, the Diphragmida are accompanied by various Endoceratidae, one of the chief divisions of the Holochoanites. In these, the conch is straight, the siphuncle is large and marginal, and the lower part of the siphuncle is occupied by numerous funnel-shaped endocones crowded so closely together as to suggest a continuous deposit, though on close examination the individual endocones often can be distinguished readily. The lower pointed ends of these funnel-shaped endocones are connected together by a continuous, narrow, central, vertical endosiphotube extending as far downward as the apical end of the siphuncle.

Similar funnel-shaped endocones occur in the Piloceratidae, which differ from the Endoceratidae chiefly in the lengthwise curvature of their relatively short conchs and in the location of their siphuncles close to the concave side of the conch. Endosiphotubes may be present, but their existence has not yet been established in an altogether satisfactory manner. Their distribution is Upper Canadian.

A peculiar type of structure occurs within the siphuncles of *Protocycloceras,* also of Canadian age. In this genus the siphuncle is more central in location, though usually not located in the exact center of the conch. The lower part of the siphuncle is occupied, as in the Holochoanites, by a close succession of transverse lamellae, but these lamellae are not funnel-shaped. In a dorsoventral direction, they slope downward at a very steep angle from the ventral toward the dorsal side of the siphuncle. Parallel to their length these lamellae are straight, but in a lateral direction they arch more or less distinctly upward along their median parts.

Another peculiar type of structure is that presented by *Buttsoceras,*[4] a genus proposed by Ulrich and Foerste, and founded on *Orthoceras adamsi* Butts,

[1] O. H. Schindewolf. *Paläontologische Zeitschrift,* Vol. 10, pp. 68–89, 1928.

[2] Genus proposed by Ulrich and Foerste and based on *Cyrtoceras cambria* Walcott, described in "Research in China," Carnegie Institution of Washington, Vol. 3, p. 98, 1913.

[3] Teichii Kobayashi. Personal communication, still unpublished.

[4] Charles Butts, "Geology of Alabama," pl. 18, figs. 22, 23, 1926.

from the uppermost Upper Canadian. In this genus the conchs are straight, the location of the siphuncle is central, the septal necks are short, connecting rings are present, all in conformity with the structure of the Orthochoanites, but in several specimens the center of the siphuncle is occupied by a long central tube, slowly tapering downward. This tapering of the central tube is in such close conformity with the tapering of the walls of the enclosing siphuncle, remaining equidistant from the latter on all sides, so as to preclude any possibility of the tube being merely some extraneous body accidentally washed into the open end of the siphuncle in its original condition after the death of the animal. Unfortunately, the homology of this tube remains uncertain, since in no specimen has its upper end been observed in contact with the inner walls of the siphuncle.

The Holochoanites include those conchs in which the septal necks extend downward at least for the length of one camera, their lower ends invaginating into the top of the neck immediately beneath. In this suborder Hyatt included not only the endoceroids and piloceroids but also the Diphragmida. However, two occurrences among the Diphragmida suggest that their structure may have been not holochoanoidal but ellipochoanoidal, the latter term having been introduced by Hyatt for siphuncles in which the septal necks are short and must be supplemented by connecting rings in order to produce a continuous siphuncle. For instance, several specimens from the central mineral area of Texas, apparently referable to *Leviso-ceras,* not only show the transverse tabulae within the siphuncle but also segments of the siphuncle which are composed of short septal necks and intermediate connecting rings. Both surfaces of the septal necks are sharply defined from the adjacent matrix, but those of the connecting rings apparently diffuse rapidly into the latter so that no sharp line exists between the rings and the matrix. Moreover, the substance of the connecting rings is slightly lighter in color than that of the septal necks. In that case the Diphragmida could originate from forms similar to those occurring in the Cambrian which have no connecting rings by the addition of connecting rings and tabulae.

A similar occurrence of short septal necks with intermediate connecting rings occurs in the orthoconic genus *Robsonoceras,* another member of the Diphragmida.

In the Texan Diphragmida here described the septa curve downward only slightly on approaching contact with the siphuncle, this downward curvature being too slight to merit the name of *neck.* They certainly are not orthochoanitic and the term aneuchoanitic (without neck) here is proposed for structures of this type.

The structure of the siphuncle of the Holochoanites may have originated by the prolongation of septal necks originally short until their lower margins invaginated into the necks immediately beneath. Since connecting rings are formed subsequent to the formation of the septal necks a holochoanitic structure could originate either from forms with or without such rings. However, the origin of the endocones of the Holochoanites could be explained more readily if ascribed to derivation from the transverse tabulae of the Diphragmida by a deepening in the concavity of these tabulae, and an enormous increase in the number of the latter, resulting in their crowding into a continuous mass. In that case the continuous vertical endosiphotube connecting the apexes of the endocones is an added feature.

Protocycloceras was referred by Hyatt to the Orthochoanites, a group of ellipochoanoidal conchs with relatively straight septal necks and connecting rings which are not expanded conspicuously. Such a reference may have been suggested by the subcentral location of its siphuncle, but is nullified by the presence of a continuous series of strongly oblique transverse lamellae or tabulae within the interior of the latter, this structure being more suggestive of the Holochoanites, though here the location of the siphuncle usually is marginal or nearly so.

In *Buttsoceras* the siphuncle is central in location and its structure also is ellipochoanoidal as in the Orthochoanites. There are short septal necks and intermediate connecting rings. But the much elongated central tube is an anomalous feature which might be an aberrant form of endocone but whose true nature at present remains unknown.

Cyrtoceroids and nautiloids with siphuncles located on the convex side of the conch made their first appearance in the Upper Canadian. Those in which the siphuncle is located on the concave side of the conch at mature stages of growth show a more ventral location at the apical end of the conch, suggesting that they are derivatives from forms in which the location of the siphuncle was on the convex side.

Although *Volborthella* in the central location of its siphuncle suggests relationship with the Orthochoanites, true Orthochoanites are not known until the Chazyan. In a similar manner, although the form of the septal necks of *Plectronoceras* suggests relationship with the Cyrtochoanites, true Cyrtochoanites also do not make their appearance until the Chazyan. The derivation of the Orthochoanites and Cyrtochoanites undoubtedly invites speculation, but at present few facts are known to serve as a basis for such speculation.

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ON THE PHYSIOLOGICAL EFFECTS OF RADIO WAVES[1]

The statement is common that only living material is heated when exposed to short radio waves. It is shown to be erroneous by the observations of Hosmer and McLennan, but because it persists we conducted a series of experiments of our own. To this end we subjected a series of simple solutions to high frequency currents.

Concentrated solutions of various electrolytes, such as potassium chloride, barium chloride, acetic acid, sulfuric acid and sodium hydroxide were found to be slightly heated, but the intensity of this heating increased with dilution to a maximum, decreasing with still further dilution. The amount of heating was found not to be the same for a given concentration of different substances, or a function of the concentration of a given electrolyte, varying, rather, with its specific electrical conductivity. Thus, normal acetic acid, having a higher resistance, was heated more than normal sulfuric acid. Such effects are reported by Helen Hosmer[2] and by J. C. McLennan and A. C. Burton[3] and our own observations are offered as a confirmation of their work.

It has also been reported that egg white and sugar solutions are heated, and that gelatine becomes warm and finally liquefies when irradiated by short electromagnetic waves. No proof has been offered to show that such heating is not due to contaminating electrolytes, for it is impossible to remove traces of salt from egg-white or gelatine without altering the proteins profoundly. But dextrose, as an example of a non-electrolyte, is obtainable in pure form by recrystallization of the material from syrup through the addition of alcohol. We found dilute solutions of such purified dextrose not to be heated by high frequency currents. When our concentrated syrups did show a slight elevation of temperature we felt that it was due to contamination with electrolytes from the containers, etc. A sample of twice distilled (crystalline) phenol was partly liquefied when irradiated, but a thermometer fixed in the mass recorded no change in temperature. Neither did solutions of low concentrations of water dissolved in the phenol or of phenol dissolved in water show temperature increases. A solution of dry hydrogen chloride in benzene remained unheated.

We feel that these findings have a bearing upon the explanation of what happens in the therapeutic use of high frequency currents in paresis and other clinical states, as well as in the studies that have been made on the selective effect of such waves on different tissues by J. W. Schereschewsky and H. B. Andervont[4] and J. C. McLennan and A. C. Burton[5]. Schereschewsky irradiated animals bearing transplantable mouse or fowl sarcoma and reported recessions in the growth of the tumors. We feel that the explanation of the selective effects is dependent upon the fact that neoplastic, "inflamed" or "injured" tissues are richer in water than normal tissues. These represent a shift in the protoplasmic system from a "dry" hydrate toward a better solution of the constituents of protoplasm in water and are therefore peculiarly sensitive to the action of radio waves. This shift, in other words, makes a better solution of electrolytes in water and is analogous to the change which is suffered by a soap or proteinate solution when heated or diluted, thereby suffering a change from what was originally a solution of water in the soap or protein to one of the soap or protein in water. A distinguishing characteristic of neoplastic growth is its ability to liquefy its medium and thus to continue its growth. Chicken sarcoma transplanted to a clot of blood plasma, for example, liquefies it within a few hours, and, unlike normal cells, divides in this liquid medium. Pathogenic bacteria evidence the same reaction when grown upon gelatine or when they produce the edema which they evoke in living matter. The liquefaction in both cases is a general reaction representing transition of a concentrated mixture of protein and salts in a water-poor medium toward a dilute solution of these salts and protein in a large amount of water, the intermediate edema representing the incomplete middle phase in the total reaction. Just as concentrated solutions are little heated by electromagnetic waves while more dilute ones are better heated, even so will a neoplasm bathed in a dilute and salt-containing solution of protein, or the more highly hydrated, soluble and edematous infected tissue be more strongly affected (heated) by such waves than the more normal, "concentrated" and water-poor tissues.

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[1] Aided by a grant from the Committee on Scientific Research of the American Medical Association.

[2] Helen Hosmer, Science, 68: 325, 1928.

[3] J. C. McLennan and A. C. Burton, *Canadian Journal of Research*, 3: 224, 1930.

[4] J. W. Schereschewsky and H. B. Andervont, *Public Health Reports*, 43: 927.

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